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CONSERVANCY CONNECTION



Fall 2020



WHO WE ARE

Working toward a sustainable future for the Amargosa River and Basin through science, stewardship and education.

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SINCERE THANKS

We thank Tanya Henderson and Julie Vargo for 5 years of dedicated service. They are creative problem-solvers who brought the organization into the 21st century by establishing a system of online communications and records. As Financial Director, Julie established an annual budget and financial plan; improved membership record keeping; taught herself design layout to produce pamphlets and media products. As stewardship manager and then Executive Director, Tanya guided and assisted contractors, interns and volunteers; instructed and organized the Board of Directors on responsibilities for fundraising and strategic planning; and much more. We are grateful for their contributions and wish both the best for the future.

Conservancy Connections

Just last October some of you attended our third "Meet the Amargosa" event at Tecopa Hot Springs. By all accounts, the weekend was successful with engaging presentations on geology and desert plants and short excursions to Tecopa marshes, China Ranch and geology outcrops.

Since then, the Amargosa Conservancy has undergone changes in focus and organizational structure. We have news to share with those interested in the Amargosa Basin and its resources.

Tanya Henderson is leaving the Amargosa Conservancy after five years of dedicated service, most recently as our Executive Director. Finding a new Executive Director is a difficult task for any small organization, but the remoteness of the Amargosa region makes this task more complicated. So the Amargosa Conservancy will continue, in the short term, as an all-volunteer organization without paid staff. This will provide time to be strategic about our next steps, after having successfully completed several large projects under Tanya and Julie Vargo's leadership. We intend to hire a new Executive Director once we identify a clear path to carry out future projects.

For the past five years, the Amargosa Conservancy's focus has been stewardship projects, including:

- China Ranch trail and trailhead improvements
- Habitat restoration for Amargosa Vole and SW Willow Flycatcher
- Restoration of OHV designated trail with interpretative signage
- Groundwater monitoring and construction of deep monitor wells

These and similar projects were funded by various grants ably administered by Tanya and Julie Vargo. Stewardship projects require hiring seasonal work crews which is further complicated by the current

pandemic. Thus the Board has elected to concentrate on programs of advocacy and education, to support continued study and preservation of groundwater and spring flows that maintain the region's unique plant and animal life, and to implement the Amargosa Wild and Scenic River designation.

Three articles in this issue describe projects involving or supported by the Amargosa Conservancy.

The first article on Nopah Range botany is by Carolyn Mills, whose thesis advisor is Amargosa Conservancy Board member Dr. Naomi Fraga, Director of Conservation Programs at California Botanic Garden in Claremont.

The second article is a Q&A discussion with Susan Sorrells about the recent translocation of Amargosa voles to upgraded marsh habitat at Shoshone. Susan Sorrells is owner of Shoshone and co-founder of the Amargosa Conservancy.

The third article illustrates the science behind our new priority of protecting groundwater resources. Research by expert hydrologist and Amargosa Conservancy advisor Andy Zdon has documented reductions of groundwater and spring flows due to upstream pumping in Nevada. Holly Alpert, past Board President, successfully secured a substantial grant award which largely funded Andy's work.

To keep you informed of issues and actions in the Amargosa Basin, we have updated our website and are working to increase outreach via social media, email and presentations.

It is natural to be apprehensive about fundamental changes in our organization; but we look forward to opportunities and challenges of the next year. We hope that as a friend of the Amargosa Basin and the Amargosa Conservancy, you will share those feelings and continue to support our efforts. 🌱

RARE PLANT TREASURES

Photo by Carolyn Mills

By Carolyn Mills

The next time you are driving between Shoshone and Pahrump in the Amargosa Basin, take a minute to look up at the beautiful mountain range that rises dramatically on the east side of highway 178, and the striking contrast between the black and white lines that streak its western face. These mountains are the Nopah Range, and they are my beloved home away from home. Their rocky peaks may look barren to the casual observer, but to me, they are teeming with a great diversity of plant life.

I am currently a graduate student working on my M.S. degree at California Botanic Garden (formerly the Rancho Santa Ana Botanic Garden) and Claremont Graduate University. For my thesis, I am conducting a floristic inventory of

OF THE NOPAH RANGE

the vascular plants of the Nopah Range, which is located in the Mojave Desert along the border of California and Nevada in southeastern Inyo County, California, on southern Paiute ancestral homelands. Few botanists have visited to document the plants there, so the diversity of plants that grow in the heart of the Nopah Range, away from the roadsides and highways that border it, have long been a mystery. The floristic inventory I am working on will result in a comprehensive list of all the plants I have encountered during my 2 years hiking through the range.

While I have found many amazing plants that haven't been formally documented in the Nopah Range previously, some of my most treasured finds are the rare species that have been flying under the radar.

Rare plants are especially important because they are inherently more vulnerable to threats like extinction. Their numbers are small, their ranges are restricted, and they can be very particular about what kinds of substrates they grow in. The Nopah Range is made up of carbonate substrates, such as limestone and dolomite, which were formed under the ancient seas that used to cover the region. Carbonate mountain ranges are uncommon in California, so the Nopah Range hosts a variety of unique plants not commonly found elsewhere in the state, almost all of which are endemic to these carbonate substrates.

So far, I have documented eight rare plants that were not previously known from the range. Their stories are below!



Limestone bedstraw, growing out of a carbonate rock with a botanist's thumb for scale. Photo by Carolyn Mills.

LIMESTONE BEDSTRAW

I first laid eyes on limestone bedstraw (*Galium proliferum*; a member of the coffee family) in June 2019 as I was attempting to scale a steep cliff en route to Nopah Point, the highest peak in the range. I saw a tiny, unfamiliar plant growing out of a narrow rock crack, so I made my way across the sharp limestone rocks to collect a specimen. As I reached my hand out and pinched the lower stem to collect it, a tarantula rushed out of the crack to defend this plant! I knew then this plant must be special. This individual of limestone bedstraw turned out to be the first record for its species collected in Inyo County. The populations in the Nopah Range are the western-most known occurrences of this species, which is distributed from eastern California through central Texas and into the northern states of Mexico. It is thought to grow only on limestone substrates.

CESPITOSE EVENING PRIMROSE

The large flowers of evening primroses are fantastically charismatic and hold a special place in my heart, so I was delighted to come across the rare cespitose evening primrose (*Oenothera cespitosa* subsp. *crinita*) in the Nopah Range. Their flowers open at night to welcome their primary pollinators, hawkmoths, so it's always memorable to come across rocky slopes decorated with their pinkish-white flowers, which can only be seen opening in the coolness of the evening and closing in the heat of the desert morning. Though it is considered a rare plant in California, this plant is widespread in the Great Basin. The populations in the Nopah Range are approaching the southwestern edge of their distribution.



Cespitose evening primrose flowers have a special floral feature called viscin threads, which hold the pollen in clumps, as seen here. Photo by Carolyn Mills.

CROWNED MUILLA

Crowned muilla (*Muilla coronata*) is a lovely member of the commonly-cultivated asparagus family. Described as "rare and seldom collected," this plant is known to reveal itself following good rain years in the desert and can be absent from the landscape in years of little rain. Its flowering can be so infrequent that after it was first collected and described as a new species in 1888, it wasn't documented again for 34 years! Fortunately, following the wetter-than-average winter of 2018-19, I found this plant in flower near one of the abandoned mines in the Nopah Range. This plant is called a geophyte, meaning it is a perennial that persists from year to year via an underground storage organ, such as a bulbs or corm. This population is at the eastern edge of its known range.



Close-up of an elegant pink funnel lily flower. Photo by Carolyn Mills.

PINK FUNNEL LILY

Pink funnel lily (*Androstephium breviflorum*) is another geophyte in the asparagus family I was lucky enough to encounter in the spring of 2019, when significant rainfall in the desert led to an abundance of geophyte blooms. They are strikingly beautiful to see in flower, with delicate blossoms borne on long, thin stems rising from sandy soils on the desert floor. This population is only the third occurrence documented in Inyo County. The distribution of this plant has been described as "extraordinarily poorly documented" by expert botanist A.C. Sanders at the University of California, Riverside so I am pleased to be able to contribute toward a more robust scientific understanding of this plant.

SCALY CLOAK FERN

Scaly cloak fern (*Astrolepis cochisensis* subsp. *cochisensis*) is the rarest plant I have found in the Nopah Range – so far, I have found only one individual plant growing in a shaded spot beneath a boulder! This fern is endemic to limestone substrates, and in California is known only from the New York Mountains and Clark Mountain, though it does occur more widely out of state. Needless to say I was very surprised to come across it and I have been looking for more ever since. This is one of the few rare plants the Nopah Range does not share with the neighboring Kingston Range to the south, though I strongly suspect it is patiently waiting to be found out there. The plant in the Nopah Range marks the very northwestern edge of its species' distribution.



Scaly cloak fern. Photo by Keir Morse.



Crowned muilla gets its name from the unique filaments of its stamens, which form an erect crown at the center of the flower, pictured above. Photo by Carolyn Mills.

GILMAN'S SPRINGPARSLEY

Gilman's springparsley (*Cymopterus gilmanii*) is an aptly named member of the carrot family, for its leaves do smell of parsley and it begins to flower in the early spring. Its distribution is limited to the Mojave Desert in eastern California and southern Nevada. The plants in the Nopah Range are about 25 miles from their closest known neighbors in Death Valley National Park's Funeral Mountains. Occurrences of this plant are usually very small, and in the Nopah Range it is only found growing in limestone benches where loose soil has collected. It is hard to find information about this plant, for like many narrow endemics of the desert, it hasn't been well-studied.



Gilman's springparsley in January 2019, just beginning to come into bud. Photo by Carolyn Mills.



A small cluster of Nevada onions, growing out of a carbonate rock crack. Photo by Carolyn Mills.

NEVADA ONION

Nevada onion (*Allium nevadense*) is a scarce perennial growing in carbonate outcrops on slopes and ridges which is closely related to the domesticated onions we enjoy eating. Its bulb is much smaller though, comparable in size to a garlic clove. Its flowers have a sweetly pungent scent, also reminiscent of garlic. The collections made in the Nopah Range are only the second and third specimens collected in Inyo County, and represent the westernmost known location for this species in the Mojave Desert.

STRIPED COTTONTHORN

Striped cottonthorn (*Tetradymia argyaea*) is the most recently detected rare plant in the Nopah Range. The only observation to date was made in late May 2020 on the west side of the range's crest. My field assistant and I made the arduous climb to the dry, rocky ridgeline on a particularly hot day, only to discover disappointingly few flowers as many plants had begun to go dormant for the summer months. We did not think we had found anything remarkable, but did note several individuals of a mysterious shrub that were just starting to bud. That plant turned out to be striped cottonthorn, and the population along the Nopah Range's crest marks the northernmost known occurrence of its species.



Striped cottonthorn in bud. Photo by Duncan Bell.

LEARN MORE

If you want any ideas for hiking routes or flower viewing spots in the Nopah Range, or want to talk desert plants, feel free to email the author at cmills@calbg.org 🌿



AMARGOSA VOLES RETURN HOME

Above: UC Davis vole team at Shoshone Spring. Photo by Susan Sorrells.

Earlier this year, the endangered Amargosa vole was reintroduced to its historic marsh habitat near Shoshone. We asked Susan Sorrells, proprietor of Shoshone Village and co-founder of the Amargosa Conservancy, about her perspective on the habitat enhancement project and reintroduction.

Amargosa Conservancy

Early in the last century, the Amargosa vole was thought to be extinct. We've come a long way from the species re-discovery and the vole officially being re-introduced into its historical habitat. Can you tell us about the early history of the Amargosa vole?

Susan Sorrells

The early history of the Amargosa vole's presence is somewhat inconsistent, but there are two known dates of vole sightings, starting at the end of the 1800's. In 1898 Vernon Bailey, on an expedition to collect mammal and bird specimens in Oregon, Nevada and California, stopped in Shoshone and documented the presence of Amargosa voles. Nineteen years later, Tracy Storer, a well-known zoologist and educator who had strong ties to UC Berkeley, returned to Shoshone and was unable to find any voles. Later in the 1930's the Amargosa vole was again identified as being present in the area, this time in the nearby Tecopa marshes.

AC

Once the Amargosa vole was listed as endangered, there were many groups and individuals who worked together towards recovering the population. Can you tell us about the nature of those partnerships, and why collaboration was key to effectively saving the species?

SS

In 1980 the Amargosa vole was listed as an endangered species in California and in 1984 as an endangered species by the US Fish and Wildlife

Service. By 1997, increasing concern about the survival of the Amargosa vole resulted in US Fish and Wildlife creating a Recovery Plan. By 2010 the status of the Amargosa Vole was even more dire and the Bureau of Land Management established an ad hoc Amargosa Vole Recovery Team. The formation of this team made it possible for more research to take place, such as studies of the vole's diet, habitat and reproduction. The creation of the Vole Team also made it possible to establish a vole colony for captive breeding at UC Davis. The team today consists of

VOLE QUICK FACTS

1. Listed as an endangered species in California in 1980, and federally in 1984.
2. Population once fell to as low as two dozen individuals.
3. Currently lives in marshes around Tecopa and Shoshone.



Photo by CA Dept. Fish & Wildlife

USFWS, BLM, CDFW, UC Davis and UC Berkeley, USGS, Shoshone Village and the Amargosa Conservancy.

AC

About this time Bill Christian and you established the Amargosa Conservancy. What was the connection between the excitement and efforts around the vole and the creation of the Amargosa Conservancy, an organization with a mission to protect the Amargosa River?

SS

A large group of citizens, led by Bill Christian and myself, were concerned about the destruction of the natural resources in the Amargosa Basin, including the resources of the Amargosa River. We wanted to make changes to ensure that the natural resources and beauty of the area would be protected, so Bill Christian and I led a campaign to create the Amargosa Conservancy. The goal was to create an organization that would protect all the natural resources of the area, and, at the same time, ensure the sustainability of the economies of the local communities through an increase in tourism, especially ecotourism. The protection of the unique biodiversity of the area includes the protection of the Amargosa vole and its habitat.

AC

You, your husband Robbie Haines, and Shoshone Village did considerable work to establish and enhance vole habitat on your property. Can you tell us a bit about the restoration methods used? This was very generous, but did you consider it a bit of a risk?

SS

As a result of my deep love for the Amargosa region I was very much concerned about the destruction of its flora and fauna and its ecosystems and so was very involved in the activities of the Amargosa Conservancy. Around 2012 one of the Vole Team leaders asked if my husband and I would consider translocating voles from the Tecopa Marshes to the Shoshone Spring where the voles first were discovered in 1898. I knew the Amargosa vole was one of the most endangered

subspecies in our region, and was excited that these translocated voles would become a lifeboat population since the habitat in the Tecopa Marshes was so threatened. At the time, we were already in the process of restoring the damaged Shoshone Spring ecosystem so that it would be a healthy desert spring ecosystem for all species, and past restoration efforts had led to saving the Shoshone Pupfish and changing its status from extinct to prolific. We have worked hand in hand with our partners during this restoration, including government agencies and also nonprofits such as the Amargosa Conservancy and The Nature Conservancy. As we pursue our goals of protecting and saving

endangered species a Safe Harbor Agreement protects us from legal prosecution under the Endangered Species Act. These partnerships have been very empowering, enlightening and rewarding.

AC

Environmental factors, such as detrimental effects on habitat in the Tecopa marshes, continue to cause concern regarding population stabilization and increases and the eventual recovery of the vole. Due to your efforts and the efforts of others, including the Vole Team, it appears that the foundation has been laid to increase, then stabilize, the population in the future. Would you share some of the senses of satisfaction, accomplishment and excitement that you feel about the recent translocation and reintroduction? What do you think can be learned from this success story?

SS

It has been extremely rewarding and educational to work with a team of talented and dedicated professionals on such a project. Because the team members represent a combination of government agencies, nonprofits and private business, we all bring a different perspective to the table

and through collaboration have been able to create new solutions to old problems. For example, at Shoshone Spring we have concentrated on creating a healthy and biodiverse ecosystem instead of simply focusing on the specific endangered species. As a result I am proud to be a part of a

team that is trailblazing new approaches toward recovery, restoration and interpretation of our environment. 🌱

“The goal was to create an organization that would protect all the natural resources of the area, and, at the same time, ensure the sustainability of the economies of the local communities...”

“I am proud to be a part of a team that is trailblazing new approaches toward recovery, restoration and interpretation of our environment.”

STATE OF THE BASIN

Photo by Patrick Donnelly

Over the past four years, the Amargosa Conservancy has sponsored an extensive hydrology study of the basin, led by professional hydrologist and AC advisor Andy Zdon. Andy's research involved measuring the surface flow of springs over time, drilling shallow wells to monitor groundwater levels over time, and chemical tracing of groundwater to determine source areas and flow paths. In addition, the US Geological Survey conducted an evapotranspiration study at several sites throughout the Amargosa basin. The goals of the overall project were to improve the understanding of the water that sustains the Amargosa River and desert ecosystems that flourish along the river, and its adjoining springs, and to provide the knowledge necessary to identify and avert impacts to those water sources.

Natural spring flows are critically important to the area's vitality -- its lifeblood -- both ecologically and economically. The Shoshone area derives its domestic water supplies mostly from springs, and Tecopa Hot Springs is a visitor destination that is the economic hub of Tecopa. China Ranch date farm obtains its irrigation water from spring-fed Willow Creek. Numerous small undeveloped springs with colorful names -- Borax, Borehole, Chappo, Christian, Crystal, Dodge City, Homestead, Horsethief, Stormy, Thom, Tule, Twelvemile, Vole, Westside -- support a diversity of plants and wildlife, and some contribute to river flow through Amargosa Canyon.

Starting in 2009, Andy Zdon's hydrology study was sponsored initially by the Resources Legacy Fund,

HYDROLOGY STUDY SHOWS SLOW DEPLETION



Drill rig for groundwater monitor well.
Photo by Andy Zdon.

then by The Nature Conservancy which resulted in drilling 4 groundwater monitor wells. Starting in 2016, in cooperation with the U.S. Geological Survey, the Amargosa Conservancy received grant funding from the California Department of Water Resources through the Inyo-

Mono Integrated Regional Water Management Program for drilling 5 more monitor wells and for related research. In January 2020 Andy published his "2020 Amargosa State of the Basin Report", with results summarized on the AC's website, www.amargosaconservancy.org.

The “2020 Amargosa State of the Basin Report” has several conclusions:

- Groundwater that supplies natural spring flows near Shoshone, Tecopa and Amargosa Canyon originates from distant recharge areas both to the north – in southcentral Nevada – and to the east, from the high Spring Mountains near Las Vegas.
- Based on chemical evidence, some groundwater is thousands of years old, since it entered permeable rock as precipitation, and its movement toward discharge at springs has been slow.
- Over time, groundwater levels in monitor wells generally show a slow drop in elevation, presumably due to groundwater pumping in Amargosa Valley to the north and the Pahrump area to the east.

- Recent reductions of spring flow are not easily measured, but historical records from decades ago indicate significant reductions over the past century.

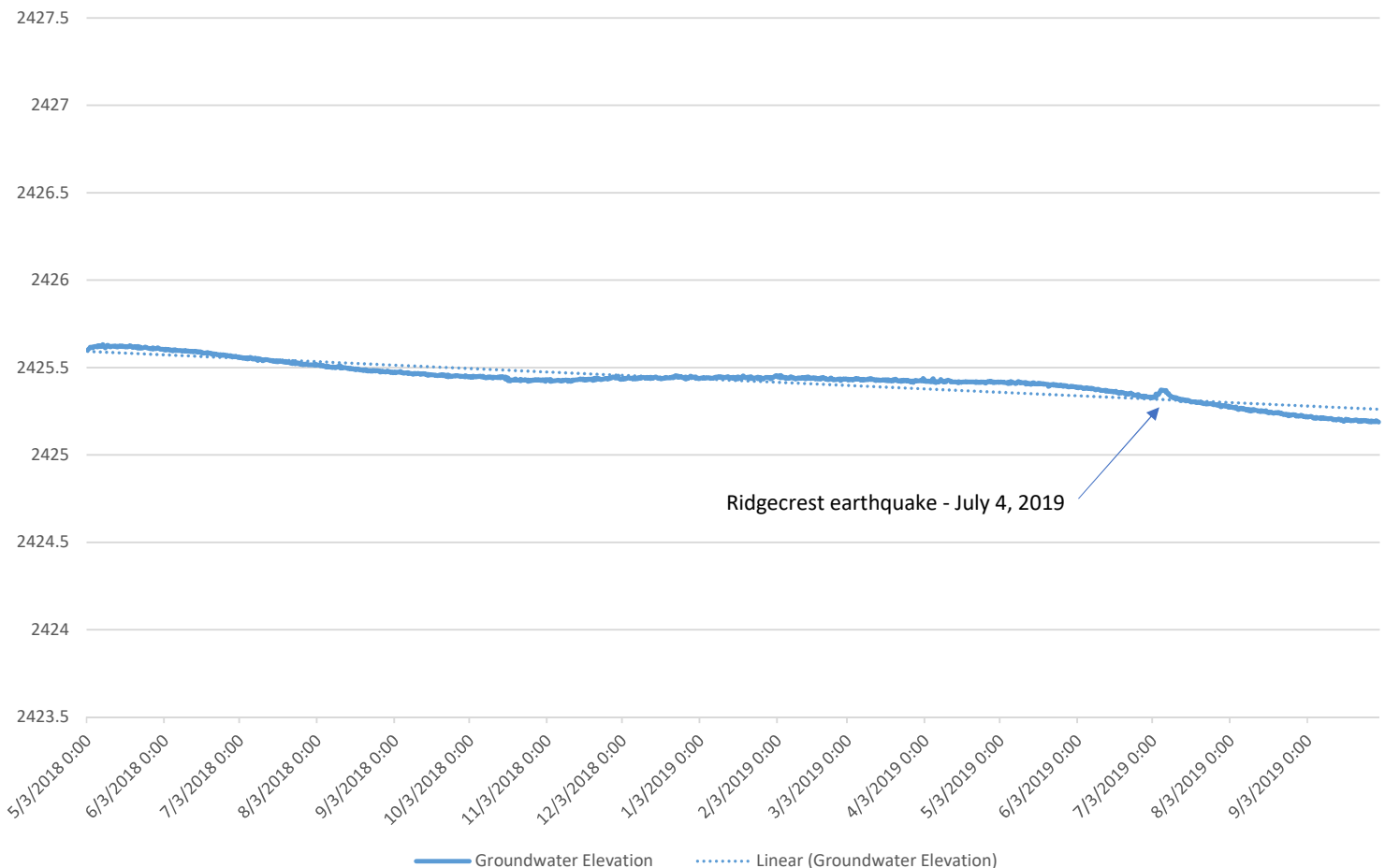
One of the report’s recommendations is to petition the California Department of Water Resources to raise the priority level of the Amargosa Basin, under California’s Sustainable Groundwater Management Act, for these reasons:

- The local economy is based on and supported by spring-flow.
- The local towns are economically disadvantaged communities.
- The groundwater system is on a downward trend due to groundwater development outside of California but within the watershed.
- Spring flows support a federally-designated “Wild and Scenic River” from Shoshone through Amargosa Canyon.

- Spring flows support habitat for the most critically endangered mammal in North America, the Amargosa Vole, and numerous other listed species, either seasonally or perennially.

Given the limited groundwater pumping in the Shoshone-Tecopa area, the Amargosa River and springs in the area will persist or decline based on groundwater management decisions in the upper part of the Amargosa Basin in Nevada where substantial groundwater pumping occurs and the proposed Yucca Mountain Nuclear Repository is located. Interstate groundwater management efforts and cooperation will be essential to protect the ecology of the Amargosa River system in California and the economy of southeastern Inyo County. 🌿

GRAPH OF GROUNDWATER LEVEL VS. TIME IN MONITOR WELL



Outcrop of Kingston Peak Formation north of Dumont Dunes, next to Amargosa River flood channel.

GLACIAL DEPOSITS

NEAR SPERRY WASH

By Bill Neill

Outside the Shoshone Museum is a geological display with a stratigraphic column showing rock formations of the Amargosa basin. In the lower part of the stratigraphic column, one sedimentary unit labelled the Kingston Peak Formation is described as "mudstone with pebbles and boulders – ancient glacial deposit . . . About 740-635 m.y."

The Kingston Peak Formation is sandwiched in the column between two carbonate units: the Noonday Dolomite above, and the Beck Springs Dolomite below. Because dolomite (magnesium calcium carbonate – MgCa_2CO_3) is derived from limestone (calcium carbonate – CaCO_3) which normally is deposited in warm shallow tropical marine

water, this arrangement raises the question – why was glacial sediment deposited in a tropical setting?

Before considering this question further, we'll examine the Kingston Peak Formation at its most accessible outcrop (pictured above), located south of Amargosa Canyon along the Sperry Wash Route, which is a legal OHV trail through the Kingston Peak Wilderness. Until 1974, trucks travelled the route carrying talc ore from the Western Talc Mine in the Alexander Hills to Union Pacific tracks at Dunn Siding, near Afton Canyon.

About 2/3 mile beyond the Sperry Wash gate, next to the Amargosa River flood channel, the outcrop

Below: Stratigraphic column of Amargosa geology displayed outside Shoshone Museum



Entrance to Sperry Wash OHV route from Dumont Dunes road, with Kingston Peak in distance.



of glacial deposit is not especially photogenic, but close inspection shows distinctive features: a variety of mostly angular rock clasts embedded in a mudstone matrix, with the thin layering of mudstone either depressed by or draped over the clasts. Geologists interpret these clasts as carried to an offshore marine basin by melting icebergs and dropped into mud that slowly accumulated from the settling of suspended clay and silt particles in quiet water.

As shown on the Shoshone Museum display, the age of the Kingston Peak Formation is thought to be between 635 million and 740 million years – a time when land plants had not yet evolved, and the most advanced marine animals were soft-bodied like jellyfish. Glacial deposits of similar age and character have been found elsewhere in the world – in Australia, Norway, India, Namibia – that apparently were deposited at tropical latitudes, as inferred from paleomagnetism and the association with carbonates.

A "Snowball Earth" or "Slushball Earth" model has been developed to explain these features. According to this theory, the Earth was heavily glaciated for 100 million years or more, mostly covered by thick ice extending nearly to the equator, at a time when most continental masses were grouped near the equator. Before and after this prolonged cold period, temperate conditions



Glacial "dropstone" in laminated siltstone of Proterozoic Kingston Peak Formation.

Photo by Marli Miller (marlimillerphoto.com).

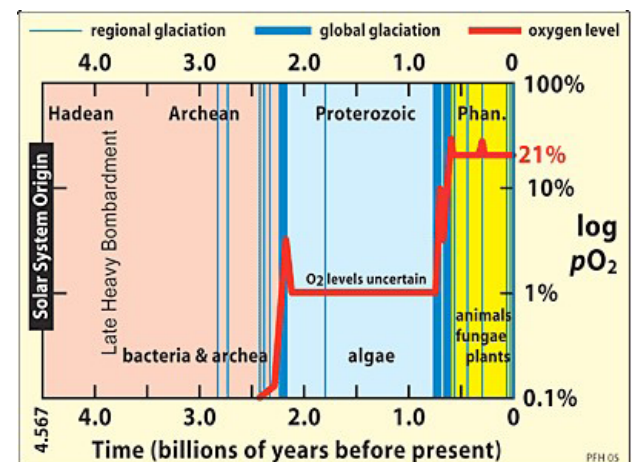
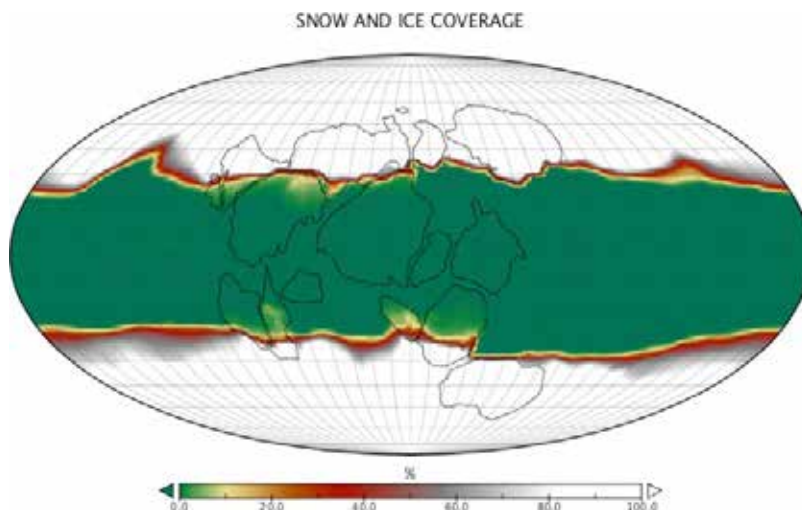
prevailed and carbonate rocks were deposited below and above the glacial unit.

According to Wikipedia, the period of global cooling "from about 850-630 mya, is believed to have been caused by early photosynthetic organisms, which reduced the concentration of carbon dioxide and increased the amount of oxygen in the atmosphere." Although photosynthesis by marine algae started about 2 billion years ago, the atmosphere's oxygen remained low during the first billion years because as oxygen was produced, it was removed by oxidation of dissolved iron in the ocean and iron minerals in exposed rock on the continents.

Eventually, dissolved iron in

seawater was removed to form "banded iron formation", now exposed in places like Michigan and Australia; and by covering much of the continents, the "Snowball Earth" glaciation slowed rock weathering and allowed the atmospheric oxygen content to rise nearly to present levels. The increased oxygen level in the atmosphere, in turn, allowed larger, more complex animal life to evolve, resulting in the "Cambrian explosion" about 541 million years ago.

This is a complex story to derive from rust-colored rocks exposed along the Sperry Wash route south of Amargosa Canyon, but it's humbling to recognize that the rock history contributes to explaining how complex life evolved, including us. 🍀



Charts from www.snowballearth.com



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PARTING SHOT

Hydrology Study Shows Groundwater Depletion

See page 7-8 and "2020 State of the Basin Report" on www.amargosaconservancy.org

Pictured above: Dodge City Spring -- Photo by Andy Zdon.